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Rubber Research Institute of Ceylon

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CONTENTS

NOTICES

DARTONFIELD GROUP—VISITORS' DAY

Those who wish to visit the Institute are requested to do so after making an appointment. No special days are set apart as Visitors' Days and the services of the technical officers can be availed of for discussion or demonstration only by prior appointment.

PUBLICATIONS

Rubber Research Institute publications comprising Annual Reports, Quarterly Circulars and occasional Bulletins and Advisory Circulars are available without charge to the Proprietors (resident in Ceylon), Superintendents and Local Agents of rubber estates in Ceylon over 10 acres in extent. Forms of application can be supplied to the Superintendents of large estates for the use of their assistants.

It will be appreciated if subscribers will return any back publications which are of no use to them.

ADVISORY CIRCULARS

The undernoted Circulars may be obtained on application at 30 cents per copy. Future issues in the series will be sent free of charge to estates registered for the receipt of our publications:—

(1) Notes on Budgrafting Procedure (Revised May, 1952).
(5) Straining box for latex (January, 1940).
(6) Notes on the care of Budded Trees of Clone Tjirandji 1 with special reference to Wind Damage (September, 1938).
(12) Warm Air Drying House for Crepe Rubber (Reprinted 1952).
(19) Density of Planting and Thinning out (December, 1942).
(21) The Control of Bark Rot and Canker (Revised, 1952)
(32) Crown Budding for Oidium Resistance (Revised October, 1954).
(33) Mechanical Felling of Rubber Trees (February, 1952).
(35) Notes on Rubber Seedling Nurseries (Superseding Circular No. 3) (February, 1952).
(36) Contour Lining, Holing and Filling, Cutting of Platforms, Trenches and Drains (Superseding Circular No. 4) (February, 1953).
(37) Manuring of Rubber (Superseding Circular No. 30) (March, 1953).
(37A) Manuring—Magnesium Deficiencies in Rubber (July, 1954).
(37B) Potassium Deficiencies (October, 1954).
(38) Planting and After Care of Budded Stumps and Stumped Budgrafts (Superseding Circular No. 8) (March, 1953).
(39) Clonal Seed as Planting Material (Superseding Circulars No. 26 & 27) (July, 1953).
(40) Tapping of Hevea Rubber (Superseding Circulars No. 17 & 34) (July, 1954).
(41) Pink Disease (July, 1954).
(42) Sale of Budwood (July, 1954).
(43) Oidium Leaf Disease (Superseding Circulars No. 22 & 28) (July, 1954).
(44) Diplodia Dieback and Collar Rot of Hevea and Blue Spot of Crepe Rubber (July, 1954).
(45) Phytophthora Leaf Disease and Stem Dieback of Hevea (October, 1954).
(46) White Root Disease of Hevea (Leptoporus Lignosus=Fomes Lignosus) (October, 1954).
(47) Ustulina Rot of Rubber Trees (November, 1954).
(48) Brown Root Disease of Hevea (October, 1954).
(49) Root Disease in Replanted Areas (Superseding Circular No. 31) (October, 1954).
(50) Orange Gall of Hevea (December, 1954).
(51) Birds Eye Leaf Spot of Hevea (December, 1954).

DIPLODIA DIEBACK AND COLLAR ROT OF HEVEA AND BLUE SPOT OF CREPE RUBBER

by

H. E. Young.

Diplodia dieback and collar rot of budded stumps and 'dark blue spot' of crepe rubber are common names of different diseases which are all caused by the same fungus *Botryodiplodia theobromae Pat.*

This fungus is one of the commonly occurring parasites on plants throughout the tropics. It occurs on a wide variety of plant species. Its different forms and wide host range have produced a considerable number of common names for the diseases produced by it.

The species as its name suggests was originally described on cacao (1892).

The principle plants of economic importance which are attacked by this fungus are, cacao, hevea, coffee, kapok, sugar cane, maize, tobacco, tea, cotton, potato, mango, papaya, banana, passionfruit, mulberry, citrus, erythinia, *Albizzia moluccana*, crotolaria, grevillea, coconut, avocado, manioc etc. etc. It also occurs on a number of plant products such as crepe rubber.

The Fungus

The fungus belongs to the imperfect group of fungi, that is its perfect or sexual stage is as yet unknown although it is suspected to be *Physalospora rhodira.* The fungus has now been shown to be identical with *Diplodia natalensis* which for a long time was considered a separate species.

The fungal threads which develop from the spores of this fungus are at first colourless but soon develop an olive, then clear brown tint. When they are old they appear brown to blackish brown and in mass produce a blue black appearance.

The threads of the fungus at first penetrate between the cells of the host plant and later when the plant parts are sufficiently weakened or broken down enter the cells. The fruiting bodies of the fungus which develop in the surface of the host tissue and later erupt on to the surface are somewhat variable in detail. These fruiting structures are minute, flask shaped and black and contain the spores of the fungus which when fully developed are discharged from an opening burst through the surface of the flask shaped body and are freed to the winds and rain.

The fungus is what is known as a secondary parasite *i.e.* it is incapable of causing damage to healthy living tissue but can enter tissue which has been injured or weakened by some other cause. Once having made an entry however it is capable of rapid development and may extend rapidly resulting in a severe disease. It is commonly found entering mechanically caused wounds or tissues which have become weakened by such causes as starvation, sun scald etc.

The fungus is very common, living on all sorts of dead vegetable matter such as dead branches, twigs, leaves, overmature fruits etc. It lives on the sugars and starches in the host and does not cause a rotting of the wood itself.

Dieback

Dieback is caused by this fungus due to a drying out of tissues as a result of its action. The threads of the fungus cause this by blocking the sap conducting vessels. Dieback occurs on the ends of branches of which the bark, due to this fungus, soon falls off assisted by the action of insects and other fungi. The mycelium of the fungus, after entry to injured tissue, rapidly progresses into the wood which becomes grey then blackish blue and the parts beyond the point of attack dry out for lack of water caused by the fungus blocking the transport vessels. The fungus enters by dead twigs or branch stubs or wounds caused by other fungi. The fungus may extend very quickly in the branch and death may occur rapidly. In other cases the fungus may progressively descend in the trunk, even to the root collar and roots, killing the tree as it progresses.

Dieback is commonest at the end of or during the wet season. It becomes less noticeable in prolonged fine weather when there is plenty of sun and relatively less rain. Often other parasites play an active part in the entry of this fungus two of these are *Gloeosporium rubrum* and *Phyllosticta ramicola* (*Petch*).

By far the most important predisposing factor to dieback in Ceylon is leaf mildew caused by *Oidium heveae*. This fungus by its attack on the leaves immediately after refoliation causes, in many cases where it is uncontrolled, a severe leaf fall which may recur several times in the one season unless conditions unsuitable for mildew development occur. These defoliations result in a greatly reduced food reserve (particularly starch) in the tree, and the extremities of the branches suffer first, resulting in their death. These dead branch ends serve as a place of entry for the dieback fungus *Botryodiplodia theobromae.*

Unless measures are taken to arrest the progress of the fungus in the affected trees death of large branches or in extreme cases the whole tree may occur.

Recognition of the disease

When 'dieback' is noticed the cause of it may be determined by examining the dead branches. The wood of these in the case of Botryodiplodia is greyish or blue black in parts and in the bark of the longest dead tissue may be seen, when a shaving is taken off by knife, the minute charcoal coloured flask shaped fruiting bodies of the fungus. These are readily identified microscopically.

Control of dieback

In Ceylon dieback can largely be prevented by correct agricultural practice which keeps the trees in good health. That is efficient Oidium control, rational manuring and tapping, proper tree sanitation by pruning and dressing of wounds of broken branches etc.

When dieback has occurred the affected branches should be pruned off well into healthy wood to make sure all the infection is removed, and the pruning scar should be treated with a wound dressing.

Maintenance of the vigour of the trees is the all important factor in prevention and control.

The spores of this fungus are present everywhere on dead organic matter and in the air and little purpose is served by burning the pruned off branches.

Collar Rot

This is another form of the same disease. In the first place sunscald, due to too much direct sunlight on the bark at the base of young plants, combined with lack of moisture in dry weather prepares the way for the entrance of the causative fungus *Botryodiplodia theobromae.* This disease occurs chiefly on plants under 2 years of age and particularly on budded plants. A longitudinal section of a diseased collar shows a zone of wood coloured grey or black, perhaps a little above or right down to the root.

The spores of the fungus germinate in cracks in the damaged bark, which may have been caused by sunscald, or on the snag of the stumps if this has not been cut off properly to allow callusing of the cut off stumps to occur cleanly.

Collar rot is also common in nurseries due to sunscald and low soil moistures causing a suitable entry point for the fungus.

In budded plants failure to prune off the snag when the scion has made sufficient brown wood and the snag becomes moribund and dies, frequently gives rise to collar rot with resultant loss of the budding. The snag forms a very suitable medium for the fungus to attack and extension of the fungus down into the living tissues of the stock and scion is easy. Snags should therefore be pruned off neatly and if possible the wound coated with a wound protective dressing.

Other forms of Botryodiplodia Attack

Botryodiplodia has also been reported as attacking roots of rubber trees. It has been shown in this case however that the fungus has always entered by above ground wounds and never by way of subterranean tissues. Fire scars and mechanical injuries are typical instances of such primary causes.

The same fungus has also been reported as present on the tapping panel but usually only in cases where bark regeneration is very slow due to lack of vigour in the trees concerned. It also occurs secondary to other primary parasites. When present on the tapping panel this fungus causes black lines to appear in the wood below the tapped surface.

Spotting of Crepe

Botryodiplodia theobromae is able to cause spotting of crepe rubber and develops during the drying process when this is carried out too slowly. The results are the development of spreading blue black dark patches known sometimes as 'dark blue spot'. The fungal threads grow in the mass of the rubber forming thick jointed microscopic hyphae of a dark brown colour. Infection is caused by the spores which are always present in large enough quantities in the air. Air pollution with the spores is always increased in the drying chambers by the use of wood for the furnaces which is itself contaminated with the fungus. These spots on the crepe produce a dirty appearance of the rubber but have no effect on its technical qualities.

Control

In order to prevent the development of spots caused by this and other fungi quick and thorough drying is essential. The sheets may also be passed immediately after milling through a solution of para nitrophenol and then dried. This dipping does not absolutely prevent the development of spots but retards it because it only causes a superficial disinfection. The method of incorporating the disinfectant in the latex itself is preferable. In this case the use of sodium dichlorhydroquinone, paranitrophenol (1%) or the oxyquinoline salt of potassium etc. have given good results.

WHITE ROOT DISEASE OF HEVEA (LEPTOPORUS LIGNOSUS=FOMES LIGNOSUS)

by

H. E. YOUNG, *Director.*

'White Root Disease' is a disease of *Hevea brasiliensis* and other plants in the tropics which is characterized by the production of a white rot in the butt and roots of the attacked trees in contrast to the brown rot caused by 'Brown Root Disease' (caused by *Fomes lamaensis Murr.*) and 'Red Root Disease' (caused by *Poria hypobrunnea* Petch). The disease is of considerable importance in rubber plantations throughout the tropics.

Causal Organism

The disease is caused by the fungus *Leptoporus lignosus* (Klot) Heim ex Pat., which is also commonly known amongst planters as *Fomes lignosus*. The former name is now considered the correct one and has superseded the latter. The fungus was described for the first time as a parasite of rubber in Mauritius under the name of *Fomes semitostus* but it was later shown that this name belonged to a different fungus described earlier.

The fungus belongs to the group known as the polyporaceae which is a family of wood rotting fungi all the species of which live on organic debris. The group is characterized by the tubular spore bearing structures which open onto the under side of the fruiting body by means of minute pores. The group is represented in both temperate and tropical areas.

Distribution and Species Attacked

Leptoporus lignosus has been recorded in Malaya, Ceylon, India, Java, Sumatra, Borneo, East & West Africa, the Belgian Congo, and in the Amazon Basin in South America. The disease occurs in a great variety of plants and is relatively common. It has been recorded on Hevea, cacao, coffee, tea, coconut, oil palm, various species of Ficus, jak, mango, bamboo, manioc, camphor etc. and on numerous leguminous and other plants used for green covers or shade such a Erythrina, Albizzia, *Leucaena glauca*, *Tephrosia candida*, Crotalaria etc.

According to some authors *Leptoporus lignosus* with its wide geographic range has a number of biological races. The West African strain is said to be more pathogenic than the Malayan one.

Nature of the Fungus

The fungus develops on the surface of plant roots etc., in the form of thin mats or flat strands about one millimetre thick. These mats and strands are very sinuous and adhere strongly to the surface on which they grow. They appear white and silky in the young stages and are more or less attached according to the soil and the host plant. The fungus becomes yellowish to reddish as it ages and forms a network on the surface of the bark and has numerous loops which form on the mycelial strands of which the network is composed.

In the outside layers of the strands or rhizomorphs (root like) the filaments or hyphae tend to form a cortical layer. Internally in the host tissue (bark or wood) white or yellowish sinuous irregular fungus strands are also to be found and these do not change colour when wetted.

The rhizomorphs act as food transport structures, as is the case with ordinary plant roots, and are able to carry food products from attacked wood for some distance.

Fruiting Bodies

The fruiting bodies of the fungus appear late in its development and sometimes occur as flat plates (resupinate forms) on the host or rock surface but more often as well developed semicircular brackets. These brackets sometimes occur one above the other in large numbers during the wet season on old abandoned wood. The fructifications are always above the ground and may develop from rhizomorphs on rocks or the soil surface itself at some distance from the attacked wood from which they really develop.

The semicircular fructifications are slender and are usually from 2 to 3 inches in diameter and ¼ to 1/3 inch thick though frequently larger. They vary somewhat in colour during development; whilst young they are brownish red with a white on yellow margin and creamy white to clear orange in colour underneath, at maturity the brownish red tint gradually changes to become a pale brownish yellow which is concentrically zoned by darker lines.

The upper surfaces appear silky and radially striated. The internal tissue, which is fibrous and woody but brittle in texture, is whitish towards the upper surface whilst the spore bearing lower tissue is brownish red or brownish fawn and the vertical tubes in this lower layer in which the spores are developed open by minute circular pores onto the lower surface. In old age the fructification becomes on the whole brownish grey.

The spores are light brown, transparent, spherical and very microscopic, being from 3 to 4 microns in diameter, and are developed on special structures on the walls of the tubes in the lower layer of the fructification.

Habits of the Fungus

Wood when attacked by this fungus softens and becomes white and rotten and the bark becomes detached. On attacked plants the foliage in the acute form of the disease dries out more or less quickly following active invasion of the root system due to interruption of food and water transport. If the attack is on secondary roots only, the weakening is progressive but if on the contrary the tap root or main stem is affected in the first place the tree may die quickly and fall from its rotted base. In the case of large trees which are attacked there may be no symptoms shown in the above ground parts.

Infection is often effected by the intermediary of a wound but it usually occurs, particularly in young trees, by direct penetration of the healthy tissue. It is said to be very rarely, if ever, that infection of living trees is carried out directly by spores of this fungus. Contamination generally occurs by means of the rhizomorphs which grow through the soil from infected trees or old dead stumps or roots which harbour the parasite. The rhizomorphs are able to extend six feet or more through the soil from their source. Rhizomorphs are most frequently encountered in moist well aerated soils and infrequently appear in tight badly aerated soils or in dry areas.

It is considered that the spores liberated by the fruiting bodies of this parasite may perhaps germinate on suitable dead wood and the fungus develop there. From this point it may then infect living plants by means of its rhizomorphs.

Whilst *Leptoporus lignosus* is by nature a saprophyte living on dead wood it is also a facultative parasite which is a danger to living plants and it is in this capacity that it is of importance in agriculture. That is, the fungus although normally requiring only dead organic matter for its support is also able, under certain conditions, to attack living material. A facultative saprophyte on the other hand would be an organism which normally is parasitic living on live material but which is able under special conditions to attack dead material.

Leptoporus lignosus cannot in nature grow vigorously in the absence of undecomposed organic matter, such as woody material, which it requires for its nutrition and hence gradually dies out as such material becomes decomposed. It lives on old stumps, roots and logs for some time depending on their speed of decay which also depends largely on their size. In this way it may live on a single large old stump for some years during which time it constitutes an ever constant source of danger to neighbouring living trees as its rhizomorphs grow through the soil or over the soil surface under thick green covers in search of susceptible host material such as the outside dead layers of bark on living trees or dead wood. In one such instance at Dartonfield the fungus was found to be active on a stump five years after clearing.

Method of attack by the Fungus

As stated above *Leptoporus lignosus* requires unrotted organic matter for its survival. In rubber areas such material is supplied by the presence of dead roots and stumps and logs. Such material however in the absence of the fungus is only a secondary danger the actual presence of the fungus being essential.

From infected wood the parasite sends out the long strands or rhizomorphs mentioned earlier which when coming into contact with live (or dead) rubber roots can attack them. In the case of living plants it appears however that contact with the plant for some time is necessary before the fungus can produce serious results. If in the meantime the source of the fungus, *i.e.* the infected old stump or root from which the rhizomorphs may have grown, has decayed the fungus loses its source of nutriment and active attack may cease with the decline in vigour of the parasite before serious invasion of the live plant has occurred and no further damage may perhaps occur.

If however the attacked area on the living plant has developed to such an extent that sufficient nourishment for the needs of the fungus is available from the killed parts of the attacked plant then the disease is able to develop further and the tree may be eventually killed.

Acute Infection

It has been found that the most spectacular damage caused by this fungus is during the first six years of growth of the young rubber trees in the field. After this the occurrence of losses in a clearing from this cause usually diminishes greatly.

This could be due to two factors:—

(*a*) disappearance of source of infection due to the rotting away of infected old roots etc.

(*b*) greater mortality of young plants than older ones when attacked due to their smaller size.

In young trees serious damage is much more likely than in older trees with their larger circumference because in the case of young trees the bark may be killed

right around the root collar or roots before the fungus has lost its vigour and attacking power due to the decay of the old wood from which it is growing.

Chronic or latent infection

In larger trees however the fungus may persist for many years living on decaying roots of those trees without, due to the large size and growth of the trees, actually killing them and producing no obvious above ground symptoms. This conditions may be termed latent or *chronic infection* as compared to the *acute* very active disease of young trees. Old trees with latent infection are frequently subject to windthrow due to the weakening of their root systems. The symptoms of the disease may then be identified on the root system.

In other cases, when old rubber trees are artificially uprooted preparatory to replanting the land with better material, numerous instances are observed in which the root systems of these otherwise healthy appearing trees are infected with the disease in the chronic condition. Such instances point to the moral that as far as possible when replanting rubber lands the stumps and roots of the old trees especially when infected should be removed in order to eliminate them as sources of infection for the young more susceptible plants which are to take their places.

The leaving of thin secondary roots in the soil is not such a danger as these with their small bulk rot quickly and so do not provide a source of food for Leptoporus, if the present, for long enough to become as serious danger.

The use of unrotted cowdung as a manure around young plants is considered dangerous by some authorities as this material has been found to support the fungus quite well and become heavily infected with it provided infection is available in the surrounding soil. Cases have been reported of young plants being killed by *Leptoporus lignosus* attack which have been previously manured with cowdung which, on examination of the dead plant has been found to be supporting a vigorous growth of the fungus.

Control Measures

Recognition of the disease. Before control measures can be taken the disease must first be recognized. In the plantation a tree which appears to be drying out with a yellowing of the foliage and perhaps (if in tapping) showing a diminishing latex yield should be suspected of being infected with a root disease and an inspection of the root collar should be made by removing the soil around the butt of the tree to a depth of about one foot and examining the surface of the bark in that region on both the main stump and the lateral roots for the presence of rot and fungus rhizomorphs.

Prevention of further spread. If the tree is found to be infected by *Leptoporus lignosus*, it is essential that further spread of the fungus from the infected tree should be prevented in order to protect neighbouring uninfected trees.

The infected tree should then be uprooted (unless it is considered it may be saved as described in category 2 under 'Root Infection', below) and the main roots traced out radially from the tree to find the extent of the disease along the roots. A line should then be demarcated beyond the furtherest extent of spread of the fungus around the tree and the infected area isolated by digging a trench around this line to a depth of two feet. All the soil removed from the trench should be thrown inside the isolation area in order to avoid the danger of throwing infected soil outside the infected area.

Removal of Infected material. The area inside the isolation trench should then be thoroughly forked over and all the roots and cover crop, which should be stripped from the site, gathered together. These roots and cover crop material together with the uprooted stump, which will have been cut off from the trunk, should then be burned together within the isolation area. On no account should any such infected material be taken away from the site.

It may be found that one or more roots of an adjacent rubber tree have also been attacked and are present in the isolation area. Such roots should also be traced back and amputated beyond the furtherest point of infection which should be included in the isolated area.

After care

The treated area should be kept clear of creeping cover crops for about two years during which time the small pieces of rubber roots which may have been left in the soil will have had time to decay and will cease to be a source of danger. The isolation area however should be thickly planted with a crop of *Crotalaria anagyroides.* This plant is very susceptible to root disease and the presence of any diseased bushes will indicate the presence and whereabouts of a piece of infected wood which was overlooked in the original cleaning of the soil. The bushes should therefore be inspected from time to time and any dead or sickly plants pulled up for examination. If the presence of *Leptoporus lignosus* is observed the source of the infection must be traced and removed and burned.

Crotalaria plants should be cut back at intervals to keep them growing otherwise they are liable to seed and die. The cutting back should however be done lightly as cutting them too low will also result in death and they will lose their value as indicators of infected soil. The isolation trench should be kept cleaned out during this period also.

Supplying

Any vacancy resulting from root disease should be supplied without delay provided the clearing is not older than two years. Stumped buddings or seedlings may be used for a further year but thereafter it is uneconomic to supply the vacancies unless they occur in a group as such young plants cannot compete with the older bigger plants already present around them and are unlikely to develop into useful trees.

Later Inspections

(*a*) *Isolation trenches.* The isolation trenches should be inspected at intervals for clearing out and any fructifications of the fungus found on the sides of the trenches collected and burned to avoid danger of spore dispersal of the fungus to dead timber which may be in the surrounding fields.

If fructifications are found on the external walls of the trench it means that the isolated area has not been made large enough and a further extension and the cleaning of the newly discovered infected area is indicated.

(*b*) *Root inspection.* In a replanted or new clearing where white root disease is prevalent, it is recommended that the above measures be supplemented by a periodical (every six months for two years) examination of the root system of each individual rubber plant, the object being to find and remove the sources of infection with the least possible delay and thereby save young plants which would otherwise be killed. The method used is to remove the soil from the collar of each young

plant to a depth of about eight inches, when the tap root and main laterals will be exposed, for a distance of about one foot radially from the stem. The work should be carried out with a pointed wooden stick so as to damage the roots as little as possible.

The plants examined can then be divided into three classes.

(1) Those in which there is no trace of Leptoporus attack.

(2) Those in which Leptoporus mycelium is found growing externally on one or more roots but has as yet caused no rot. This can be checked by carefully scraping the bark under the rhizomorphs to see if penetration has occurred. If penetration has occurred the bark will be discoloured. If no penetration is present the bark will be fresh and laticiferous.

Plants in this category can usually be saved by gently rubbing the fungus mycelium off the roots with a cloth soaked in 2 per cent. copper sulphate solution in water. The fungus must of course be traced to its source and the latter removed as described above. Any roots which have actually become diseased and which are found during the tracing of the fungus should be cut off and removed and the cut stub treated with a wound protecting paint.

Such plants should be marked to signify treated.

(3) In the third class are placed plants of which the tap root or one or more of the exposed lateral roots are found to be actually diseased. These plants should be removed and burned and the area treated as above and supplied.

There is no object in examining very young plants *i.e.* plants whose roots have not yet penetrated beyond the planting hole. Unless a piece of infected material were introduced with the filling or the plants were infected in the nursery such plants are seldom likely to have contracted the disease.

Precautions in Replanting old areas

When it is decided to replant old rubber areas it is advisable to ensure that the stumps of the old trees are uprooted. In Ceylon this operation is carried out (*a*) either manually, by digging around the base of the trees and cutting the lateral roots and further digging until the tree falls, or (*b*) by cutting the lateral roots and having the trees pushed over by an elephant or (*c*) by the use of a manually operated winch by means of which the trees are pulled out with a considerable amount of the larger roots attacked (see advisory circular No. 33).

Immediately after uprooting, all stumps should be examined for the presence of root disease and diseased areas treated according to the above recommendations.

In uninfected ground there is little harm in leaving the uprooted stumps and logs to decay particularly as they serve as a good source of manure, supplying both mineral salts and organic materials for the new crop (see Advisory Circular No. 37). With avenue systems of planting the logs may interfere with the planting rows and some cutting and moving may be necessary. In many instances however the logs are removed for sale as firewood and the stumps may be removed from the planting rows if necessary either manually or with the aid of a winch or an elephant which allows lining, holing, terracing and draining to be carried out as required.

Poisoning of old rubber prior to Replanting

In Malaya the practice of poisoning the old rubber trees with sodium arsenite and replanting amongst the standing poisoned old trees has been resorted to to reduce cost of replanting. There is some damage caused usually of the order of 5 per cent., to the young stand by the falling of dead limbs and branches when this method is used.

This method has also been used in Ceylon in some cases. It has been claimed that poisoning of the old trees with sodium arsenite kills the root system of the tree quickly and thus allows the root system and stumps to commence rotting early, and this early rotting should therefore remove the danger of the stumps and roots as a source of Leptoporus infection at an earlier stage.

It has however been noted in Ceylon that old infected dead stumps and logs may be still active sources of Leptoporus infection even five years after death. Experiments in Malaya have also shown that larger infected roots buried in the soil may contain active infection for a considerable time depending on their size. The larger the pieces the longer they take to rot. Short pieces of root three inches in diameter have in Malaya been found to be still actively infected after at least two years.

Many instances have also been noted in Ceylon of fructifications of *Leptoporus lignosus* appearing on old poisoned trees and stumps for several years after their killing.

Some attention is now being given to the use of other poisons than sodium arsenite which it is thought may be more certain to kill the entire root system. Such likely substances are the hormone types of weed killers which are systemic in their action.

In Ceylon a number of cases have been examined, and others reported, where very serious losses in replanted fields have occurred due to Leptoporus infection following arsenical poisoning of the old stands. It would appear in these cases that the fungus has been present on the old trees as a chronic infection, which, following the poisoning of the trees, has, with the rapid provision of an abundant food supply due to the death of the trees by poisoning, been able to develop into an acute epiphytotic in the new clearing with resultant heavy loss and consequent expense in decontamination and supplying.

The difficulty with poisoned trees is that the stump and root system cannot be adequately examined for presence of infection so that control measures may be taken if the fungus is found to be there. If however *Leptoporus lignosus* is not present in the area the disease will not occur until it is introduced.

The presence or not of the fungus is a risk which must be borne in mind when considering poisoning. There are very few areas in Ceylon's old rubber except in the drier districts where such a risk can be afforded.

Nursery Infections

If the disease is present in the nursery and infected seedlings or budded stumps are planted unnoticed in the field that field may become infected with resulting serious loss as the fungus on the young plant may become established in the new clearing and may then commence its destructive work.

Nurseries should therefore only be laid down on known uninfected sites and all woody material should be removed from the soil during the construction of the nursery.

A place in the nursery which becomes infected should be immediately isolated by trenching and the area stripped of plants. The plants from such an infected site should preferably not be used even if appearing uninfected. If they must be used and the risk of planting them is taken the root system should be thoroughly wiped with the 2 per cent. copper sulphate solution in water described above before the plants are sent from the nursery to the field.

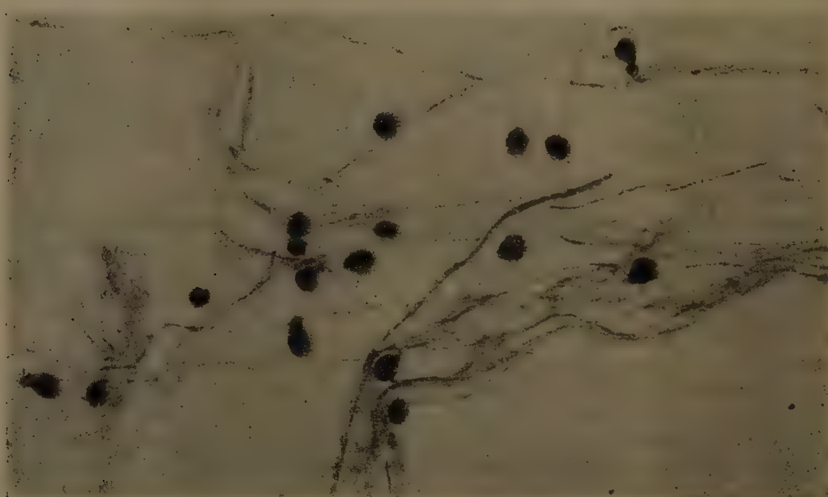
PHYTOPHTHORA LEAF DISEASE AND STEM DIEBACK OF HEVEA

By

D. M. FERNANDO

General

Phytophthora Leaf Disease and Stem Dieback is caused by the fungus *Phytophthora palmivora* Butler. Among other economic plants in Ceylon attacked by this fungus are Arecanut, Cacao, Coconut, Bread fruit and Papaw.



Phytophthora palmivora Butler

Photomicrograph showing hyphae and pearshaped sporangia

The Fungus

The fungus belongs to the Phycomycete group and is closely related to *Phytopthora infestans* de Bary which causes 'Irish Blight' of potatoes.

The mycelium of the fungus develops from spores which germinate on the plant surface and grows internally both between and inside the host cells. It is only seen on the surface at the time of spore production and in times of very favourable high humidities.

The spore bearing bodies are of two kinds (*a*) external asexual (*b*) sexual and internal in the attacked tissues. The second type is generally the rarer.

The asexual spore bearing bodies (sporangia) appear for a short time on the surface of the parasitized plant parts in the form of a very thin powdery whitish or yellow mass. The pear-shaped sporangia germinate only in the presence of water and produce zoospores which, after their liberation, swim by means of two cilia or motile threads, for some time in the film of water on the plant surface and then settle-down and germinate by producing filaments which penetrate the host tissue and develop new infections.

The sexual spores (oospores) are formed inside the host tissue where they remain as resting spores until the host tissue in which they are formed decomposes thus liberating them to germinate on favourable surfaces where they may be blown or washed.

Independently of these two methods of reproduction the fungus also produces chlamydospores or cysts. These are formed by a thickening of the cell walls of the mycelium of the fungus and the development of cross-walls. They are developed in conditions unfavourable to the growth of the fungus such as during a dry season and on old fungus filaments. These chlamydospores can germinate in 24 hours in water producing an abundance of fungus threads but no zoospores.

The development of *Phytophthora palmivora* is mainly influenced by the surrounding humidity. The infection, whether by sporangia or oospores is always effected by means of the intermediary of zoospores which they produce and which require the presence of free liquid water on the surface of the plant.

A high air humidity, light rain, or persistant mist covering the surface with fine adherent water droplets, constitute the most favourable factors for the development of the fungus.

Violent rain causing a strong washing effect is not favourable as it washes the spores off the plant surfaces.

The best temperature for development of the fungus is between 68°F and 77°F.

The sporangia represent the organs of rapid multiplication of the fungus during favourable weather conditions and the oospores and chlamydospores constitute conservation forms to insure the continued existence of the parasite in unfavourable circumstances of dryness. On Hevea *Phytophthora palmivora* causes leaf-fall, pod-rot, stem dieback tapping panel diseases such as black stripe and canker, and bark rot. In India phytophthora leaf-fall is a major problem of rubber. Leaf fall due to this fungus has also been noted in Ceylon, Indochina and South America.

Conditions favouring phytophthora attack

Frequent light rain-fall, mists, and the moist conditions prevailing in dense plantings and heavy canopies generally favour Phytophthora. A few days of bright sunshine often retards leaf-fall considerably. The conditions of humidity and free—water required render it difficult to forecast the emergence and intensity of Phytophthora attack. Therefore it is difficult to decide on definite measures for prevention and control of the disease, which imply treatment immediately prior to conditions favourable for its development occurring.

Nursery Attack

Phytophthora palmirora causes a dieback of leaf-stalks and green shoots of young rubber plants. In this case the shoots take on a water soaked appearance, become

blackened in patches and then may die back to brown wood. Under favourable humid conditions the bark of brown wood will also become infected by the disease which may cause death of the entire plant.

Control

Rapid recognition of the disease as indicated by drooping leaf stalks and blackened green shoots is essential. The infected plant parts should then be excised and a light coating of fungicide applied to the snag.

In order to prevent further spread of the disease in the nursery all plants should be sprayed with a copper fungicide such as Bordeaux mixture or a proprietary copper preparation such as 'Perenox'. Spraying should be carried out at fortnightly intervals. Usually two treatments should be sufficient.

Attack in young clearings

In young clearings Phytophthora attack can also occur and its characters are similar to those appearing in the nursery as described in the preceding section under Nursery attack. The conditions prevailing in young clearings, up to the time when the leaf canopy closes, where good ventilation and comparative dryness of leaf surfaces occur do not favour the appearance of Phytophthora leaf fall.

Control

As in the case of nursery attack control measures consist in (*a*) cutting back diseased shoots to healthy brown wood and (*b*) spraying uninfected as well as affected plants with a copper fungicide to prevent further spread.

Leaf Fall and Pod Rot of Mature Trees

In recent years Phytophthora leaf fall and pod-rot on mature rubber trees seems to be increasing in Ceylon. It is difficult to say whether this is due to the better canopy and hence more humid conditions which are a result of successful Oidium control or to the increasing awareness on the part of the industry of the importance of disease problems, and hence more frequent recognition of such conditions. The leaf-fall is characterized by a blackening of the leaf-stalk, or a browning of the leaf-blade with subsequent fall of the mature leaf *with the leaf-stalk.* These symptoms are quite different from the normal seasonal leaf fall or wintering which is characterised by the reddening of the leaves and drying out of the leaf stalk.

The pod-rot is characterized by a water-soaked, blackened appearance of the pod with the rot extending to the seed. The pod-rot may continue even after the seed has fallen.

Secondary Infections

Arrested Phytophthora infection sites may serve as entries for other organisms such as *Botryodiplodia theobromae Pat* giving rise to diplodia dieback but this is very infrequent.

Host Resistance to Phytophthora

It has been recently observed by some planters in India that, under the climatic conditions prevailing there, clone BD 10 seems to be resistant to Phytophthora leaf fall but these observations are still tentative rather than conclusive. In South America certain clones which include *H. benthamiana* in their ancestry have been developed and found to be resistant to Phytophthora leaf fall as well as South American Leaf Blight. A draw-back of these clones is however their mediocre yields.

Methods of Control of Leaf Fall

The fungicides used for control of Phytophthora diseases on other crops usually consist of various forms of 'insoluble' copper which are used as 10 to 15 per cent. dusts incorporating different types of diluent such as talcs, clays, silicas etc. In South India 10 to 25 per cent. copper dusts are being used against Phytophthora on rubber. With regard to rubber a great disadvantage in the use of copper is its deleterious effect on latex for even extremely minute quantities of copper coming into contact with latex gives rise to a tackiness of prepared rubber. In South America zinc ethylene bisdithiocarbamate ('Dithane Z .78" or Parzate') was found to be superior to copper sprays against both South American Leaf Blight (*Dothidella ulei*) and Phytophthora attack. The above substance is used against Dothidella at a dosage of one to two pounds per 100 gallons of water at 8 days intervals. Properties of these newer organic fungicides are their high efficiency, narrow specificity, and generally low toxicity to higher plants and animals. In laboratory tests ferric dimethyl-bis-dithio-carbamate was found to display a high toxicity to *Phytophthora palmivora:* this is a black finely powdered dust generally sold at 76 per cent. concentration as Ferbam, Fermate, Fermspray of Karbam Black. The toxicity of this susbstance to higher plants is claimed to be less than that of sulphur.

Though this Institute has not had the opportunity to determine the efficiency of this product as a preventive against leaf fall in the field, it may be a good opportunity for estates having a high annual incidence of Phytophthora leaf fall to use it as a 10 per cent. dust mixed with the sulphur used in the last few rounds of Oidium dustings. Information thus obtained as to a lowered incidence of Phytophthora attack in the form of leaf fall, pod-rot, or bark diseases will be of great value, especially as Phytophthora attack is highly variable according to topography and prevailing climatic conditions. The price of these new organic fungicides is still rather on the high side for routine full scale commercial dusting without diluents such as the sulphur dust suggested above.

MANURING

MAGNESIUM DEFICIENCIES IN RUBBER

By

D. H. CONSTABLE

It is a common sight nowadays to see young clearings, especially PB 86 with an intervenal yellowing of the leaves. Its characteristics are illustrated in Photographs 1 and 2 and it may be described as a golden yellow colouration starting at the edges of the leaves and extending down between the main lateral veins and spreading towards them. The yellow bands are frequently broken by thin green lines marking the position of the largest minor veins spreading between the main laterals. At a distance the alternate patterning of green laterals and yellow deficient areas presents a zebra like appearance and is frequently called 'zebra striping'. This appearance is common to Magnesium deficiency on a number of plants and is also found on Rubber in Malaya with the same deficiency.

In many cases here it seems to pass away after 2-3 years. This is presumably due to the rapid growth of roots taking in a much larger volume of soil and hence foraging more efficiently for the elements in short supply. Although the deficiency may rectify itself there is a period of a year or more during which the leaves are very short of chlorophyll (*of which Magnesium is essential constituent*) and therefore very inefficient. It is probable that the trees receive a considerable set back and it appears desirable to take steps preferably to prevent its occurrence, otherwise to cure it on appearance.

The present, heavier Potash manuring is undoubtedly a contributory cause. It has been widely found that plants receiving sufficient Potash will reveal Magnesium deficiencies rapidly if these exist. The remedy, of course, is not to cut the Potash but to supply the Magnesium.

There are two main sources of Magnesium namely Dolomitic Lime and Magnesium Sulphate. The former occurs in Ceylon and is comparatively cheap being about Rs. 100/- per ton analysing 20-30 per cent. MgO. It is comparatively insoluble and should form an excellent long term source of Magnesium for a young planting. It is however, not so satisfactory for curing a deficiency and it cannot be used in a mixed fertiliser, so requires a separate application.

For this purpose a soluble Magnesium salt such as commercial Epsom Salts is needed and in very bad cases may even be used as a 2 per cent. spray on the leaves in dry weather.

A further source is the mixed Potash/Magnesium salts formerly known as Kainites. The use of these is considerably more economic in that both Potash and Magnesium are being bought in the same compound. Such mixed salts could be used in any of the present rubber manurial mixtures.

Recommendations

(*a*) **Normal Manuring:**

(1) Dolomitic Lime	1st year ¼ lb. per tree
(*not less than* 20 *per cent. MgO*)	3rd year 1½ lb. per tree
	5th year 3 lb. per tree

Broadcast in the root feeding circle.

(2) Manurial Mixture

- Order your present mixtures to contain 1/3 part of MgO for every 1 part of K_2O *e.g.* R 4:6:5: with Mg.

Sulphate of Ammonia	100 lbs. N	=	20 lbs.
Saphos Phosphate	100 lbs. P_2O_5	=	30 lbs.
Muriate of Potash	50 lbs. K_2O	=	25 lbs.
Commercial Epsom Salts	50 lbs. MgO	=	8 lbs.

and preferably increase the total yearly application by about one-fifth to make up for the extra constituent.

(*b*) **Deficiency Treatment**

(1) Dolomitic Lime 2 lbs. per tree forked in.

(2) Magnesium Sulphate (*Epsom Salts*) ½ lb. per tree forked in plus 1½ lb. Dolomitic Lime will give quicker results.

(3) Magnesium Sulphate—Make up 2 per cent. solution 2 *lb. Epsom salts to* 10 *gallons water*) together with a 'sticker' and spray the trees 2 or 3 times at weekly intervals. Broadcast 1½ lb. per tree of Dolomitic Lime as well. This will give the fastest cure.

In both (2) and (3) above the addition of Dolomitic Lime to the soil is advisable to maintain the satisfactory Magnesium status for which the Epsom salts are a temporary cure. If ,however, a Magnesium containing manurial mixture is used the Dolomitic Lime can be omitted.

POTASSIUM DEFICIENCIES

By

D. H. CONSTABLE

The Institute has now ample evidence to illustrate, (*a*) the existence of potassium deficiencies in rubber, (*b*) the adverse effect of such deficiencies on growth and yield, (*c*) the approximate extent of such adverse effects, (*d*) the amount of remedial treatment required, (*e*) the areas in which it is to be expected, (*f*) that PB 86 is a particularly susceptible clone.

Case Histories

Our attention was drawn several years ago to longstanding cases of foliage yellowing on estates in Southern Province and Ratnapura district. Work had been done without success to cure these as a Magnesium deficiency. Our foliar analysis data on these estates showed Potassium to be about 20 per cent. normal, Nitrogen about 70 per cent. normal and Phosphate 50-80 per cent. normal.

Remedial treatment consisting of applications of Muriate of Potash and Sulphate of Ammonia were started on both estates. Owing to financial difficulties the S.P. estate had a lapse of treatment of one year however. Twelve months ago the Ratnapura case was considered cured by the P.D. concerned but we felt it desirable to wait 12 months for a possible recurrence, which is most severe in the last four months of the year. No further symptoms have appeared and the yield per acre per annum on a 12 acre field which for five years has been 800±50 lb. is 826 lb. after only 8 months tapping. On the S.P. estate a 90 per cent. cure has been effected to date and the P.D. concerned reports an appreciable rise in crop.

Our third case concerns a Horana-Ingiriya estate on which we have a manurial experiment of Nil, P, NP, PK, and NPK. After 3 years growth the girth figures are:

> Nil 7.38 inches, P 7.91 inches, NP 8.16 inches, PK 9.82 inches and NPK 9.92 inches. The effect of potash therefore is 1.84 inches extra girth or 34 per cent. Readers will appreciate that as the trees grow more rapidly this deficiency effect is likely to get appreciably worse (it was 21 per cent. twelve months ago) and by tapping age we may reasonably expect an effect of at least 50 per cent. on growth alone.

A further case to which we have just been called has recorded a significant drop from a yearly average of 1,500 lb. per acre for PB 86 and this drop is coincident with the appearance of the yellowing symptoms. The estate is adjacent to one of those previously mentioned.

These cases then, constitute direct proof of the existence, and magnitude, of a potassium deficiency. In addition we have cases of the same foliage appearance backed up by similar leaf analysis data for about a dozen more estates of which six are in the Ratnapura district.

In two of the cases in which young clearing have been concerned very heavy applications of the R 4:6:5 have cured the trouble. The remainder have

not been under study for a sufficient length of time or have had follow up postponed till we had information from our earliest experiments. It is notable that in most cases plenty of manure had been given and in the first Ratnapura case R 400 had been regularly applied at full rates.

Discussion

The fact that the leaf nitrogen is deficient is of considerable interest and the question is posed whether there is a simultaneous soil deficiency of several elements. The fact that R 400 has been used obviously disproves this for Nitrogen and Phosphorus. We are therefore left with the conclusion that severe deficiencies of Potassium have an adverse effect on the uptake of Nitrogen by the plant.

There is also a well known phenomenon of 'antagonism' whereby the shortage of any one nutrient can be greatly exacerbated by heavy applications of other nutrients. It is quite obvious therefore that heavy applications of Nitrogen (290 lb. S of A per acre) have greatly worsened the Potash deficiency which then affects Nitrogen uptake so that the final result of these applications is to cause severe Nitrogen starvation in the tree.

Appearance

The appearance is fairly typical and is best seen by looking at the clearing from the top of a neighbouring hill when the all over yellow colour or patches of bright yellow can be seen contrasting strongly with the surrounding green foliage. The trouble is not easily seen from within the clearing unless it is very bad. It occurs typically where there is any opening such as wind damage, or a road, bungalow compound etc. We believe that the increased total light striking trees in such a case causes greater leaf activity and growth hence emphasising the shortage of Potassium and making the symptoms more pronounced.

Seen, close to, the leaf yellows from the edges inwards with no differentiation of veins or tissues. The yellowing is uneven and the leaves generally have a central irregularly shaped patch of bright green. Scorching of the leaf tip spreading downwards towards the stalk is a further symptom in advanced cases. It is probable that the yellowing is largely a symptom of the Nitrogen deficiency and the scorch of Potassium deficiency.

Remedial Treatment

(*a*) *Young clearings.*—Heavy applications of R 4:6:5 (if not already being used) will probably cure the trouble. However it is best to use a mixture of 100 lb. sulphate of ammonia, 100 lb. saphos, 100 lb. muriate of potash at the full rates recommended in Advisory Circular No. 37 and apply four times a year.

(*b*) *Mature Clearings.*—We have found that quantities of 2-4 lb. each of Muriate of Potash and Sulphate of Ammonia are needed according to the severity of the deficiency. These should be applied at rates of ½ lb. each every 2 months for eight months of the year (2 lb. each per year) between March and October according to the weather and must be forked or pocketed to get below the soil surface. Four small pockets per tree is quite satisfactory and both manures can be applied at a cost of 1 labourer per acre per application.

Unless the deficiency is a very mild one two years application (4 lb. of each manure to each tree altogether) is recommended and it will take two years before the symptoms are finally clear. Thereafter no recurrence is to be expected, in our opinion, if R 4:6:5 is used regularly but those who prefer it may use the mixture given under Section (*a*) at the same rates as they would give R 4:6:5.

Economics

This treatment will cost per tree between 60 cents and Rs. 1/20 for manures and 10 to 20 cents for labour in the case of mature trees.

The evidence we have set out for growth and yield suggests that yields may be cut back by 200-400 lb. per acre as a result of this trouble. It should be particularly noticed that the loss of this crop not only means the loss of profit in that amount, but automatically raise the cost of production and thereby lowers the profit on the remaining yield. Therefore in estimating the economics of applying about Rs. 1/50 per tree of manure and labour it must be remembered that the increased yield to be expected costs, mainly, only the tappers poundage, together with handling and freight after manufacture.

What the expected increase is to be we cannot say but we believe that where the deficiency exists remedial treatment should raise PB 86 yields to a level of 1,000-1,200 lb. per acre or should restore it to previous levels where a decline has set in.

Clonal observations

It should be noted that PB 86 is particularly susceptible to this deficiency and steps should be taken with both young and old clearings accordingly. PB 86 is also susceptible to Magnesium deficiency and it would appear that the drawback of this clone is that it is a less efficient forager for nutrient than other clones and hence no risks should be taken with its manurial treatment.

The deficiency has also been demonstrated on MK 3/2, Glenshiel 1 and PR 107 and possibly TJ 1 and 16.

Occurrence

The Ratnapura district, probably because it is mostly quartzite (gemstone gravel), appears to be the most likely area together with its topographical prolongation through Ingiriya to the sea. The Southern Province particularly where Citronella grass was the previous crop is also a likely area. Similarly areas with a bad war time manuring history and which have had intensive food crop inter cultivation are to be regarded with suspicion. Finally we believe it is likely that areas containing a 'cabook' layer will give this deficiency.

Manuring

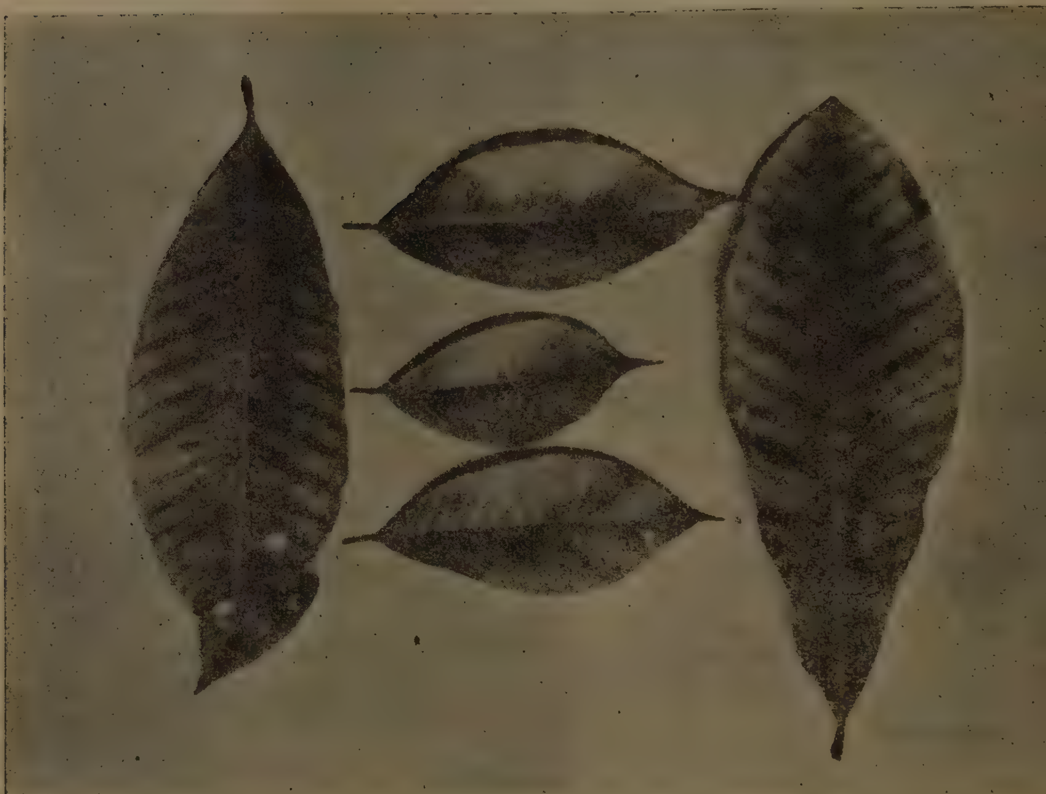
We have shown through our estate manurial experiments (published in the Annual Reports) that a balanced NPK mixture has come out consistently on top from growth measurements. We have shown that a mixture such as R 400 can have severely adverse effects on the wrong soil types. We therefore have no hesitation in recommending that R 400 be dropped entirely.

Purely as a tentative suggestion we would give the following sets of manurial mixtures:

	Sulphate of Ammonia	*Saphos*	*Muriate of Potash*
R 4:6:10	100 lb.	100 lb.	100 lb.
R 4:6: 5	100 „	100 „	50 „
R 4:4: 2	100 „	70 „	20 „

The first for young clearings on potassium deficient soils, the second as a good all-round mixture and the third for use by individuals who are satisfied that Nitrogen is their principal need.

We do not propose, at the present stage of investigations, to make these mixtures (apart from R 4:6:5) official but they do form a basis upon which those responsible for estimates and policy may formulate a programme.



Three Potassium deficient leaves flanked by two Magnesium deficient leaves for comparison.

"Note the much smaller size of the Potassium deficient leaves"

MANURING IN INDONESIA

By

A. P. A. Vink

(Reviewed by D. H. Constable)

Ir Vink has recently carried out a comprehensive survey of the results of all manuring experiments on Rubber in West Indonesia (Archief Voor de Rubbercultuur December, 1953, Vol. 30 No. 3.) As comparatively little information on the subject is available and because this article brings out a number of important points it seems well worth bringing to the notice of the Ceylon Planting Industry.

It should be noted that the manuring recommendations are based on soil types, of which they distinguish eight varieties, five volcanic (graded by age), one derived from weathered rock, and two marshy soils. Much of Indonesia lies in the actively volcanic area and therefore has frequently received soil forming material in the form of lava and volcanic dust. Such material is rich in minerals and weathers very rapidly to form fertile soils. The older types of such soil however will be leached and of much lower fertility status than the young soils. The age of these soils is correlated with a decrease in potassium to a very positive deficiency status. We probably have no geological parallel to these soils in Ceylon. The Indonesian types 5 and 6 however are strongly lateritic in character and developed from volcanic dust and weathered rocks respectively. These are differentiated mainly by their need for potassium manuring.

The types 7 and 8 are marshy and margalitic soils of a type not utilised for rubber in Ceylon.

Having briefly discussed the basis of manuring recommendations in West Java we will go on to consider the main body of the article. It will be convenient and preferable at many points to quote direct from Ir Vink's original text. The article covers 161 manuring experiments covering all types of rubber *i.e.* nurseries, young plantings, and mature plantings, with every combination of fertiliser.

Chapter IV

'There is a fairly general opinion in practical rubber cultivation that manuring of rubber plantations tappable or already tapped is of no importance. This is in general an incorrect statement. Several reasons are quoted in the following to show how this idea has arisen.

(1) A fairly large proportion of the manuring experiments on productive plantations have not given the spontaneous manuring reaction which was apparently expected.

(2) Manuring was expected to have an effect on latex production.

(3) Most manuring experiments were carried out when techniques were not advanced.

(4) The duration of most tests was short *i.e.* 1-2 years.

(7) Most of the experiments were carried out on old planting material on which the absolute effect would be smaller than with modern planting material'.

He goes on to point out that some experiments which were followed for 10 years after the last application of manure were showing valuable effects about 4 years after manuring and continuous economic residual effects thereafter.

'The use of modern planting material from which the production can be a multiple of that from old planting material is of very great importance for the evaluation of satisfactory manuring. Assuming that the percentage effect of one manuring is the same *e.g.* 10 per cent., then a 500 lb./acre planting gives 50 lb. more, and a 1,500 lb./acre planting 150 lb. more for the same total cost'.

Chapter V

Contains a discussion in greater detail of some of the manurial experiments. They have tested out the useful amounts of phosphate in the planting hole and find no advantage with more than 1 lb. per hole so this is now their recognised amount.

Chapter VI

Ground protection, soil improvement, fertilisers and ground tillage are the subjects of this chapter and the author says that because of the extremely long term nature of these matters it is difficult to deal accurately with them. Certain generalisations however can be made.

'The preservation of the top soil in the case of tropical perennial cultures is of paramount importance for the estate seeing that growth and production are distinctly affected by it'. There follows a discussion on drainage with particular relation to the heavy clay soils (which we do not have).

'The opinions on the value of green manures (cover crops which in Indonesia are slashed at intervals) are divided at present owing to the changed conditions; some aim at a homogeneous, pure leguminous cover crop which owing to high wages is often impossible to attain, others adhere to the view that a permanent grass meadow may not be detrimental. Lastly, there is also a platonic love for leguminous crops but in practice the line of least resistance is taken. As regards ground protection we are of the opinion that it is better to have grass than bare ground ('clean weeding'). This does not mean that we consider a grass crop desirable'. . . .

'Van der Veen who quotes among others that the conversion of grass to Centrosema increased the rubber yield 20-30 per cent.'.

'On the basis of the experiences quoted the following solutions can be named.

(i) For grounds on which a cover can be maintained without difficulty a mixed cover crop of 3 or 4 creeping legumes on 80 per cent. of the area and other harmless creeping weeds on the remainder. Light periodical tilling (once every 2-3 years) and generous manuring is recommended.

(ii) For all other soils a bushy cover about knee high, now and then clipped, with tapping passages. To consist of 50 per cent. legumes 25 per cent. creeping weeds. Periodical manuring (once every 2-3 years). This system is being used in South Sumatra.

(iii) For neglected old plantations interplanting with Albizzia.

Practical advice on manuring. There is not yet sufficient data for proper recommendations particularly on the quantitative effect likely to be produced. However they can make reliable recommendations for the known soil types. Types of planting are divided into (*a*) Nurseries (*b*) Young plantations (*c*) Under-developed plantations (*d*) Mature productive plantations.

For (*a*) they recommend about 1/6 oz. Sulphate of Ammonia and 1/10 oz. Saphos every 2 months on potassium rich soils while on others a 5-5-5 fertiliser at about 1/3 oz. per plant per 2 months.

(*b*) 'A good manuring system for young rubber plantations, is, according to the experience gained, the best and most profitable form of manuring in rubber cultivation'.

He comments that soil type (i) occurs only in exceptional cases and that type (ii) does not occur over large areas. These are the highly fertile soils. Soil type (iii) 'In general it may be said that with regard to rubber cultivation these soils respond favourably to rapid manuring with phosphate plus some nitrogen'.

They give applications twice a year and double the quantities every year. The approximate applications (making allowance for their use of double super-phosphate) are per tree:

1st year	1st application	2 oz. of 4-8-0	(100 lb. S of A	to 130 lb.	Saphos).
	2nd ,,	2 ,, ,,	Do	Do	Do
2nd year		4 ,, ,,	Do	Do	Do
		4 ,, ,,	Do	Do	Do
3rd year		8 ,, ,,	Do	Do	Do
		8 ,, ,,	Do	Do	Do
4th year		16 ,, ,,	Do	Do	Do
		16 ,, ,,	Do	Do	Do
5th year		32 ,, ,,	Do	Do	Do
		32 ,, ,,	Do	Do	Do

They expect to be in tapping at the 5th year, otherwise the quantities will be:

6th year	...	64 oz.
	...	64 ,,
7th year	...	8 lb.
	...	8 ,,

'We have described the whole scheme in order to illustrate the earlier mentioned principle of yearly doubling the amount of fertiliser'.

'If anywhere, then in manuring of young rubber plantations care should be taken lest wisdom be deceived by economy'.

Soil type 4.

1st year	1st application	1½ oz. of 4-4-5	(100 lb. S of A 70 lb. Saphos 50 lb.
	2nd ,,	1½ ,, ,, ,,	Muriate of Potash)

and so forth on the principle of yearly doubling. This soil is one in which potassium has a favourable effect *in the presence of* nitrogen and phosphate.

Soil type 5.

1st year 1st application $1\frac{1}{2}$ oz. of 2-4-10 (100 lb. S of A 130 lb. Saphos 200 lb.
2nd „ „ „ „ Muriate of Potash).

and so on again. This is a soil type with a major need for potash and Vink comments that the manuring scheme should be rigidly adhered to.

Soil type 6—which probably is most akin to Ceylon Rubber soils is divided into two sub classes, one treated as soil type 4 and the other as type 5 for manuring purposes.

Soil type 7 *and* 8—have no manuring scheme as their major trouble is good drainage.

(*c*) Under-developed plantations 'it is difficult to give a definite scheme. It depends greatly upon the case history and to what extent and in what respect a plantation has become deficient. In many cases the under-development of a plantation is a consequence of not applying the manuring scheme required for the soil type concerned. It is very doubtful whether in such a case arrears can still be compensated in a satisfactory manner'.

(*d*) Productive plantations. 'The following potential manuring system is likely to have, roughly and within certain limitations, a favourable effect on productive plantations.

Soil type 1. Unknown.

2. 2. lb. Sulphate of Ammonia per tree.

3. $1\frac{1}{2}$ lb. Sulphate of Ammonia and $\frac{3}{4}$ lb. Saphos per tree.

4. 1 lb. Sulphate of Ammonia and $\frac{3}{4}$ lb. Saphos and $\frac{1}{2}$ lb. Muriate of Potash per tree.

5. $\frac{1}{2}$ lb. Sulphate of Ammonia and $\frac{3}{4}$ lb. Saphos and 1 lb. Muriate of Potash per tree.

6. 2 lb. Ammonium Phosphate (equivalent to $1\frac{1}{2}$ lb. Sulphate of Ammonia and $1\frac{1}{2}$ lb. Saphos).

'Effect obtained in many cases 10-25 per cent. increased production over a period of 1 year'.

7 & 8 Unknown.

'Little or nothing is known about the response of rubber to manuring with trace elements. Perhaps part of the favourable effect of natural phosphate and Chile Saltpetre can be attributed to their action. Unless future tests should prove our opinion to be wrong we consider this problem to have at present insufficient practical value'.

Chapter VIII

Conclusions.—'In general it may be stated that the relation between the growth and production on the one hand and soil and climate on the other is extremely complicated as compared with other crops. This can be partly attributed to the relatively great tolerance of rubber for less favourable environmental conditions partly however it has to be taken into account that the sensitivity of rubber always increases for the following two reasons:

1. Part of the present rubber plantations have still been planted on forest clearings which in future will hardly be possible.

2. In proportion to the greater use of plant material of new selection, a better care of the plantation will become more essential'.

The article concludes with remarks on the need for more carefully planned research on a soil regional basis together with co-operation between planter and scientist if the former are to have detailed and accurate manuring recommendations which take into account the important point of probable return for outlay.

The reviewer apologises for the somewhat fragmentary nature of the foregoing, due to the necessity for compression and interpretation of a 40 page publication primarily for research workers.

We would like to call the readers attention to the high degree of agreement on principles, between the Indonesian workers and the R.R.I.C. On such matters as care of young plantations and high yielding clonal material, the dangers of eçonomy on such material, and the difficulties of retrieving a bad start, almost indentical statements appear in this publication and in our recent Quarterly articles. For this reason the verbatim quotations have been included in the review.

The final point worthy of note is the changing attitude towards manuring mature productive plantings. This represents a major change in policy but is obviously justified if one considers the material used and the state of soils on which replanting is done. Together with the recommendations for full mixtures and good quantities over a considerable area of soil it makes a drastic change in our current ideas on methods of manuring in Java and Sumatra and may come as a surprise to many Ceylon planters.

RUBBER RESEARCH INSTITUTE OF CEYLON

Draft minutes of the 130th meeting of the Rubber Research Board held at the Ceylon Chamber of Commerce, Colombo, at 2-30 p.m. on Wednesday 11th August, 1954.

Present:—Mr. W. P. H. Dias, J.P. (in the Chair), Mr. G. H. Carter, Mr. H. Creighton, Major T. F. Jayawardena, M.P., Mr. W. Herbert de Silva, Gate Muhandiram Arthur D. S. Jayasinghe, Dr. A. W. R. Joachim (Director of Agriculture), Mr. B. Mahadeva (Rubber Controller), Mr. L. J. de S. Seneviratna (Deputy Secretary to the Treasury), Dr. H. E. Young, (Director) and Mr. C. D. de Fonseka, (Administrative Secretary).

An apology for absence was received from Senator C. F. W. Wickramasinghe.

1. Board:

The Chairman welcomed Major T. F. Jayawardena, M.P. who had been nominated to represent the House of Representatives in place of Major Montague Jayawickrema M.P. with effect from 15th July, 1954.

2. Minutes:

(*a*) *Confirmation*—Draft minutes of the meetings held on 7th June and 2nd July, 1954, which had been circulated to members, were signed by the Chairman.

(*b*) *Matters arising from the minutes:*

1. *Plant Pathologist*—Agreed that an expert be obtained under the Colombo Plan for a period of two or three years and that Mr. D. M. Fernando, Assistant Mycologist, should understudy him during this period.

2. *Transfer of Small-holdings Department*—As recommended by the Special Sub-Committee, it was agreed that this matter be reconsidered in about two years' time after the termination of the Rubber Replanting Scheme.

3. Reports and Accounts:

(*a*) *Investments*—Reported that:

1. Rs. 100,000/- stock of Ceylon Government 3¼ per cent. National Loan 1956 had been sold.

2. Rs. 5,000/- stock of Ceylon Government 3 per cent. Loan 1954 had matured on 1st August, 1954.

(*b*) *Purchase of a Hirst spore trap*—The purchase of a Hirst spore trap and accessories for use in Oidium control work was approved.

(*c*) *Senior Staff bungalow at Nivitigalakele*—Agreed that the vacant Senior Staff bungalow at Nivitigalakele be rented to the A.S.P. Matugama.

4. Staff:

(*a*) *Agronomist*—The terms of re-engagement of Mr. D. H. Constable, Agronomist, whose present contract terminates in April, 1955, were considered.

Agreed that Mr. Constable should attend the 14th International Horticultural Congress to be held at Scheveningen, Holland, in August/September, 1955,

(*b*) *Chemist's visits to scientific institutions in U.K.*—A list of scientific institutions to be visited by the Chemist while he is on leave in U.K. was approved.

(*c*) *Technical Assistant to the Director*—A Committee consisting of the Chairman, the Director, Dr. Joachim and Mr. W. H. de Silva was appointed to interview suitable candidates and make a recommendation to the Board.

(*d*) *Assistant Staff*—Changes in staff since the last meeting were reported.

5. Contribution to British Rubber Producers' Research Association:

It was agreed that the full annual contribution to the B.R.P.R.A. be met by the Board with effect from 1955.

6. London Advisory Committee:

(*a*) *Annual Report for* 1953—was tabled.

(*b*) *Draft minutes of the sixtieth meeting of the Committee and* 59*th meeting of the Technical Sub-Committee*—were tabled.

7. Publications:

The Combined 3rd and 4th Quarterly Cicrular for 1953 (Conference Number) was tabled.

The meeting then terminated.

(Sgd.) C. D. de Fonseka,
Administrative Secretary.

Dartonfield,
Agalawatta
3-9-1954.

RUBBER RESEARCH INSTITUTE OF CEYLON

Draft Minutes of the 132nd meeting of the Rubber Research Board held at the Planters' Association Head Quarters, Colombo, at 2-30 p.m. on Monday 1st November, 1954.

Present:—Mr. W. P. H. Dias, J.P. (in the Chair), Mr. G. H. Carter, Mr. H. Creighton, Mr. W. Herbert de Silva, Mr. W. D. Gunaratne (Acting Deputy Secretary to the Treasury), Major T. F. Jayawardena, M.P., Gate Muhandiram Arthur D. S. Jayasinghe, Mr. B. Mahadeva (Rubber Controller), Dr. H. E. Young (Director) and Mr. C. D. de Fonseka (Administrative Secretary).

An apology for absence was received from Dr. A. W. R. Joachim (Director of Agriculture).

1. Board:

The Chairman welcomed Mr. W. D. Gunaratne, C.C.S. (Acting Deputy Secretary to the Treasury) who had been nominated to serve on the Board in place of Mr. L. J. de S. Seneviratne.

He also congratulated Mr. Seneviratne on his appointment as Permanent Secretary to the Ministry of Finance and thanked him for his services as a member of the Board since 21st March, 1953.

2. Minutes:

(*a*) *Confirmation*—Draft minutes of the meetings held on 11th August and 22nd September, 1954, which had been circulated to members, were signed by the Chairman.

(*b*) *Matters arising from the minutes:*

Agronomist—Agreed that Mr. D. H. Constable, Agronomist, be offered re-engagement for a further period of three years with six months leave at the termination of the contract.

Gate Muhandiram Arthur D. S. Jayasinghe came into the meeting at this stage.

3. Decision by Circulation of papers:

Export of rubber clones to Australia—It was reported that all members had agreed to the exportation of five yards budwood of each of clones AVROS. 49, AVROS. 255, LCB. 870 and the NAB. series. Arrangements had therefore been made for despatch of the budwood through the Australian High Commissioner.

Major T. F. Jayawardena, M.P. came into the meeting.

4. Experimental Committee:

Recommendations made at meeting held on 21st September, 1954.

(*a*) *Additional power line to Senior Staff bungalows*—Consideration of this item was postponed until the estimates for 1955 were considered and it was then decided that this could not be provided owing to the necessity to economise.

(*b*) *Director's report for the first half year* 1954—was adopted.

(*c*) *Research Programme for* 1955—was adopted subject to the acceptance of the recommendation that more intensified work be undertaken in connection with the control of Phytophthora leaf and stem diseases.

(*d*) *Inventory Report for* 1953—was approved.

(*e*) *Supplementary Votes*—Four supplementary votes amounting to Rs. 17,806/- were approved.

(*f*) *Identification of clones*—The recommendation that the fee chargeable from estates for identification of clones be increased to Rs. 15/- per day was approved.

(*g*) *Visiting Agent's Report.*

1. *Survey*—Quotations were considered and arrangements made for surveying 760 acres at Hedigalla and 17 acres at Nivitigalakele, demarcating plots and preparing plans incorporating already surveyed areas.

2. *Acting Superintendent*—Agreed that Mr. L. Wijegunawardena be appointed Acting Superintendent while Mr. G. W. D. Barnet is on leave in 1955.

5. Report and Accounts:

(*a*) *Receipts and Payments Account for the quarter ended* 30*th June* 1954—was approved.

(*b*) *Draft Estimates of Income and Expenditure for* 1955—Draft estimates providing for income and expenditure as follows were approved:

Estimated income			Rs. 1,456,410.00
Estimated Expenditure:			
Revenue	Rs.	1,429,170.00	
Capital	,,	617,500.00	,, 2,046,670.00
Estimated excess of expenditure over income			Rs. 590,260.00

As the estimated surplus at the end of 1955 was considered to be insufficient to meet the Board's development programme a Committee consisting of the Chairman, the Director and Messrs. G. H. Carter, W. D. Gunaratne and B. Mahadeva was appointed to examine the Board's finances and make recommendations regarding possible methods of providing the necessary funds to finance the development programme.

6. General Items

(*a*) *NAB. series rubber clones*—The Chairman reported the receipt of a letter from Messrs. Bois Bros. & Co., Ltd., Agents for the Nabunnatenna Syndicate Ltd. stating that they were agreeable to budwood of these clones being sold without agreement in future. This fact had been made known to all those who had purchased budwood of these clones from the Institute.

(*b*) *Sulphur dusting of small holdings and small estates*—The receipt of a grant from the Rubber Controller towards the cost of a trial sulphur dusting scheme to be carried out by the Small-holdings Department on certain selected small holdings and small estates in the Kegalle district during the next dusting season was reported. It was noted that preliminary arrangements for the work had been made already.

8. London Advisory Committee:

Draft minutes of the 4th meeting of the Agricultural Sub Committee held on 1-7-54 were tabled.

9. Any other business:

(*a*) *Exchange of clones with other countries*—The present position regarding the despatch and receipt of clones to and from Malaya, Indo China and Indonesia was noted.

The meeting then terminated.

(Sgd.) C. D. de Fonseka
Administrative Secretary.

Dartonfield,
Agalawatta.
1st December, 1954.

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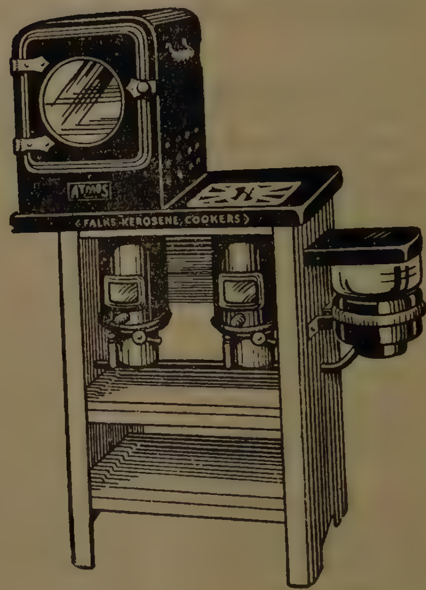

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Note.—The Laboratories and Head Quarters Offices of the Institute are situated at Dartonfield Estate, Agalawatta, Telephone No. 26, Agalawatta, Telegraphic address 'Rubrs' Agalawatta. There are two Experimental Stations, one at Nivitigalakele, Matugama, and the other at Hedigalla, Latpandura. The Office of the Smallholdings Dept. is at 33 Clifford Place, Colombo 4. Telephone No. 84205, Colombo.

All enquiries and other communications should be addressed to the Director, Rubber Research Institute of Ceylon, Agalawatta.